

NATIONAL CLIMATIC DATA CENTER

THE SPRING OF 1997

Reviewing Four Significant Weather Events

1993 Weatherstock



National Environmental Satellite, Data, and Information Service

INTRODUCTION

This report provides a review of four major weather events of the spring of 1997:

- An outbreak of tornadoes and flooding on March 1.
- A severe snowstorm in the northeast on March 31-April 1.
- Severe flooding in the northern plains in April.
- A violent tornado outbreak in Texas on May 27.

These four events resulted in an estimated 107 deaths and at least \$2-3 billion in damages.

TORNADOES AND FLOODING -- MARCH 1, 1997

On March 1, 1997, a severe weather situation with tornadoes and very heavy rainfall erupted along a nearly stationary front from Texas to West Virginia. At mid-afternoon on Saturday, an outbreak of strong to violent tornadoes in Arkansas, northern Mississippi, and western Tennessee resulted in 29 deaths, including 26 in Arkansas. Several of the tornadoes have been estimated as Fujita scale F4 intensity, with winds in the 207-260 mph range. This was the deadliest U.S. outbreak since March 27, 1994, when 42 people were killed in Alabama, Georgia, and South Carolina. Fortunately in this outbreak, the National Weather Service issued tornado warnings from 10 to 32 minutes before the tornadoes struck, using NEXRAD radar to provide much more lead time than previously possible.

This event also produced unusually heavy rainfall from northeast Arkansas through western Tennessee and southeast Missouri, and into much of Kentucky, southern Indiana and Ohio, and West Virginia. In many areas, the rains fell on nearly saturated ground left by the snows and rainfall of the past few months. In parts of northern Kentucky, rainfall rates averaged at least one inch per hour for a 12-hour period on March 1.

Following is a state-by-state account of the impact:

Arkansas--26 people killed by tornadoes; 18 counties declared federal disaster areas; approximately 1200 homes damaged or destroyed. Arkadelphia was hardest hit with sections completely destroyed. Following is the preliminary tornado track information for the most deadly of the F4 tornadoes:

Tornado path began in the southwest part of Clark County with major damage and loss of life in Arkadelphia. Damage path width of .25 to .60 miles in this area with some F4 damage. Tornado continued through Hot Spring County and much of Saline County, and reached F4 intensity across a .80 mile damage path as it moved through the Shannon Hills area and finally into Pulaski County. Total path length was 80 miles. 16 people were killed by this storm.

Texas--Two killed by severe thunderstorms and high winds.

Mississippi--Two deaths as a result of tornadoes. The Mississippi River exceeded flood stage at several points, including Vicksburg, due to incoming water from the Ohio River.

Tennessee--Six people killed by tornadoes and flooding; 12 counties declared federal disaster areas; about 900 homes damaged or destroyed.

Kentucky--21 people killed by flooding; 101 counties declared federal disaster areas; over 75,000 homes damaged or destroyed, and \$250-500 million in damage. The Ohio River crested on March 7 in Louisville at about 16 feet above flood stage. The town of Falmouth (population 2700) was almost totally destroyed, with water over 8 feet deep in town. The 24-hour rainfall amount of 10.48 inches in Louisville erased the previous state record of 10.40 set in Dunmore on June 28, 1960. Louisville's storm total of 13.04 was also the greatest of any of the reporting stations with data available thus far.

Ohio--Five people killed by flooding; 17 counties declared federal disaster areas; over 5500 homes damaged or destroyed, and over \$200 million in damage.

Indiana--One death due to flooding; 13 counties declared federal disaster areas.

Missouri--One death due to flooding.

West Virginia--Three people killed in flooding; 16 counties declared federal disaster areas; over 4000 homes damaged or destroyed.

The above damage estimates are preliminary and subject to revision, and several states have yet to provide final estimates. A total of 67 deaths have been attributed to this event, with damages estimated at approximately \$1 billion overall. The last significant flooding along the Ohio River occurred in 1964, resulting in 11 deaths and about \$50 million damage. Since that time, a great deal of development and increased population on the region's flood plains have increased the vulnerability for some of the people in the area. Prior to 1964, the "great flood of 1937" was even more severe, with some towns erecting flood walls shortly thereafter. These flood walls (including one protecting Louisville) prevented this year's flooding from taking an even greater toll.

Total Precipitation (inches, amounts of 3.00 or more), February 28 - March 3, 1997, as reported in National Weather Service bulletins:

St Station	Lat.		Lon.		Precip.
	dg	mn	dg	mn	
AL Alabaster	33	15	86	49	3.49
AL Gadsden	33	58	86	5	4.72
AL Muscle Shoals	34	45	87	37	3.55
AR Jonesboro	35	50	90	39	3.12
GA Gainesville	34	18	83	51	3.15

GA Peachtree City	33	22	84	34	3.24
GA Rome	34	21	85	10	3.02
IL Brookport	37	8	88	38	5.27
IL Metropolis	37	9	88	43	7.25
IL Shawneetown	37	43	88	10	4.87
IN Boonville	38	3	87	16	3.68
IN Evansville	38	3	87	32	3.40
IN New Albany	38	18	85	50	9.07
KY Barkley Lake	37	1	88	13	7.96
KY Bowling Green	36	58	86	25	8.28
KY Cadiz	36	52	87	49	7.41
KY Cannelton Lock	37	53	86	46	10.40
KY Cobb	36	59	87	46	6.03
KY Dawson Springs	37	10	87	41	6.65
KY Dixon	37	31	87	41	6.75
KY Elk Creek	38	6	85	22	8.86
KY Elkton	36	49	87	9	7.40
KY Fort Campbell	36	39	87	28	8.61
KY Fort Knox	37	53	85	58	9.90
KY Frankfort	38	11	84	52	9.28
KY Fredonia	37	13	88	4	9.53
KY Fulton	36	31	88	53	3.37
KY Grayson 2E	38	20	82	54	5.94
KY Grayson 3SW	38	18	82	58	6.56
KY Hickman	36	34	89	11	3.65
KY Jackson	37	36	83	19	3.97
KY Kentucky Lake	37	1	88	16	6.35
KY Lexington	38	2	84	36	8.26
KY Louisville	38	11	85	44	13.04
KY Madisonville	37	20	87	30	6.20
KY Marion	37	20	88	5	8.17
KY Paducah	37	4	88	46	6.76
KY Paradise	37	16	86	59	8.39
KY Princeton	37	6	87	53	9.35
KY Prospect	38	21	85	37	9.53
KY Providence	37	24	87	45	9.23
KY Rough River Lake	37	37	86	30	9.70
KY Sebree	37	36	87	32	7.54
KY Shepherdsville	37	59	85	43	10.53
KY Smithland	37	8	88	24	4.36
MO Cape Girardeau	37	14	89	34	3.54
MO Charleston	36	55	89	20	5.66
MO New Madrid	36	35	89	33	4.53
MO Sikeston	36	53	89	35	6.10
MS Greenwood	33	30	90	5	3.24
MS Natchez	31	37	91	18	3.92
MS Tupelo	34	16	88	46	5.51
OH Beverly	39	33	81	38	3.77
OH Carpenter	39	8	82	12	6.58
OH Jackson	39	3	82	38	6.67
OH Marietta	39	25	81	27	4.84
OH McArthur	39	15	82	29	5.55
OH McConnellsville	39	39	81	51	6.83
OH Nelsonville	39	28	82	14	4.48
OH Patriot	38	44	82	20	8.20

OH Salem Center	39	3	82	16	6.21
OH South Point	38	25	82	34	6.44
TN Bradford	36	4	88	49	6.31
TN Cades Cove	35	34	83	51	3.51
TN Camden	36	4	88	6	6.05
TN Crossville	35	57	85	5	4.04
TN Dyersburg	36	0	89	24	7.51
TN Humboldt	35	49	88	54	5.25
TN Huntington	36	1	88	25	3.57
TN Jackson	35	36	88	55	5.30
TN Medon	35	28	88	52	6.79
TN Memphis	35	3	90	0	5.50
TN Morristown	36	10	83	24	3.71
TN Mt. Leconte	35	39	83	26	4.92
TN Nashville	36	8	86	41	4.51
TN Newfound Gap	35	34	83	25	5.80
TN Rutherford	36	8	89	0	10.52
TN Sugarland Center	35	41	83	32	3.13
WV Alexander	38	47	80	13	4.15
WV Buffalo	38	37	81	59	6.83
WV Cairo	39	12	81	9	4.32
WV Charleston	38	21	81	38	4.89
WV Clarksburg	39	18	80	14	3.41
WV Creston	38	57	81	17	5.12
WV Cross Lanes	38	26	81	46	5.92
WV Elkins	38	53	79	51	3.47
WV Fellowsville	39	20	79	50	3.33
WV Glady	38	48	79	43	3.48
WV Hamlin	38	17	82	6	5.56
WV Huntington	38	22	82	33	5.19
WV Mannington	39	32	80	20	4.00
WV Parkersburg	39	21	81	26	4.49
WV Philippi	39	9	80	3	3.98
WV Rock Cave	38	50	80	20	4.18
WV Sandyville	38	54	81	40	4.77
WV Spencer	38	48	81	21	6.23
WV Terra Alta	39	27	79	33	3.08
WV Valley Head	38	33	80	2	3.07
WV Webster Springs	38	32	80	25	4.70
WV West Union	39	18	80	47	3.79
WV Weston	39	2	80	28	4.38

Note: Data for numerous additional stations are available from the National Climatic Data Center (contact information shown at end of report).

Description of Figures (times are UTC, subtract 5 hours for Eastern Standard Time, 6 hours for Central Standard Time):

Figure 1: GOES (geostationary) colorized infrared image at 0915 UTC on March 1, 1997, showing thunderstorm development from northern Mississippi northeastward through the Ohio Valley. The coldest (strongest) thunderstorm tops appear dark red.

Figure 2: GOES visible image at 1515 UTC on March 1, 1997, showing thunderstorm development expanding southwestward into Arkansas.

Figure 3: GOES visible image at 2045 UTC on March 1, 1997, showing tornadic thunderstorms over Arkansas (arrow shows tornadic cell near Arkadelphia).

Figure 4: Rainfall analysis (contour) for February 28 - March 3, 1997.

Figure 5: POES (polar orbiting) AVHRR enhanced image showing Ohio River flooding on March 10, 1997.

NORTHEAST SNOWSTORM -- MARCH 31 to APRIL 1

On March 31 - April 1, the northeast was hit by a major snowstorm/nor'easter that produced 1 to 3-foot snowfall totals over a large area of southern New England into southeastern New York. Boston recorded its third-heaviest snowfall on record with 25 inches. This amount roughly equaled what had fallen thus far during the 1996-1997 winter season in Boston (as contrasted with over 100 inches for the 1995-1996 winter season).

Several hundred thousand customers were without electricity during and after the storm due to the heavy/wet nature of the snow. This included approximately 250,000 customers in Massachusetts, over 100,000 in New York, and about 85,000 in Connecticut. Damage to trees in the area was extensive. High winds were also a problem with gusts in the 50 to 70 mile per hour range common along the coast. In Boston Harbor, the tip of one of the masts of the USS Constitution ("Old Ironsides") was sheared off by the winds. Blue Hill Observatory reported a wind gust of 72 mph.

Several locations which reported their water equivalent for the precipitation included (values shown in inches): MA--Fairhaven (3.53), Hull (5.32); RI--Providence (3.06), Tiverton (3.08), N. Foster (3.58).

Snowfall (amounts of at least 20 inches), March 30-April 1, 1997, as reported in National Weather Service bulletins:

St Station	Lat. dg mn	Lon. dg mn	Snowfall (inches)
NY East Jewett	42 14	74 8	37
MA Milford	42 10	71 31	36
NY Platte Clove	42 10	74 9	35
MA Worcester	42 16	71 52	33
RI Burrillville	41 53	71 23	31
MA Shrewsbury	42 18	71 43	30
MA Blue Hill Obs	42 13	71 7	30
MA East Woburn	42 29	71 6	30
MA Marlborough	42 21	71 33	30
MA Northbridge	42 7	71 41	30
NY Windham	42 18	74 12	30

MA Acton	42	29	71	26	29
MA Grafton	42	12	71	41	29
NY Prattsville	42	19	74	26	29
NY Broome	42	28	74	21	28
NY Gilboa	42	24	74	27	28
MA Newton	42	20	71	12	27
MA North Woburn	42	32	71	9	27
MA Randolph	42	11	71	3	27
MA West Townsend	42	41	71	44	27
MA Hingham	42	14	70	55	26
MA Littleton	42	32	71	28	26
NH Wilton	42	51	71	44	26
NY Berne	42	35	74	11	26
MA North Cambridge	42	24	71	8	26
MA Boston-Logan Arpt	42	22	71	2	25
MA Wakefield	42	30	71	4	25
NY Westerlo	42	31	74	3	25
MA Maynard	42	26	71	27	25
RI North Foster	41	51	71	44	25
MA Manchester	42	35	70	46	25
MA Hull	42	18	70	53	24
MA West Boylston	42	22	71	47	24
MA Worthington	42	25	72	56	24
NJ West Milford	41	6	74	24	24
NY Stamford	42	24	74	38	24
PA Christiana	39	57	76	0	24
RI Cumberland	41	54	71	23	24
RI West Cranston	41	46	71	31	24
VT Stratton Mtn. Ski Area	43	6	72	52	24
MA Winthrop	42	23	70	58	24
MA Taunton-NWSFO	41	57	71	8	23
MA Dalton	42	28	73	10	23
NY Slide Mountain	42	1	74	25	23
VT West Wardsboro	43	2	72	51	23
MA Norton	41	58	71	11	23
MA Milton	42	15	71	5	23
MA Walpole	42	10	71	15	23
MA Attleboro	41	56	71	18	22
NJ Wantage	41	15	74	33	22
RI Woonsocket	41	59	71	30	22
NY Claryville	41	55	74	34	22
MA Swampscott	42	28	70	54	21
CT Norfolk	41	58	73	13	21
CT Putnam	41	55	71	55	21
MA Lynnfield	42	32	71	2	21
MA Monterey	42	11	73	13	21
MA Mansfield	42	1	71	13	20
MA Lenox	42	21	73	17	20
MA Marshfield	42	5	70	42	20
MA Tyngsboro	42	41	71	26	20
MA West Framingham	42	17	71	28	20
MA Woburn	42	29	71	9	20
NH Frankestown	42	59	71	49	20
NY Stormville	41	32	73	44	20
VT Bromley Mtn. Ski Area	43	12	72	55	20

NH Weare	43	5	71	44	20
RI Providence	41	49	71	25	20

Note: Data for numerous additional stations are available from the National Climatic Data Center (contact information shown at end of report).

Description of Figures (times are UTC, subtract 5 hours for Eastern Standard Time, 6 hours for Central Standard Time):

Figure 6: GOES visible image at 2045 UTC on March 31, 1997, showing well-developed nor'easter.

Figure 7: GOES visible image at 1302 UTC on April 2, 1997, showing the snow cover left by the storm (note the Finger Lakes in central NY state).

Figure 8: Snowfall analysis (contour) for March 31 - April 1, 1997.

NORTHERN PLAINS FLOODING

A long winter of numerous heavy snowstorms and the ensuing spring snowmelt accounted for this disaster. Also, an early April blizzard which dumped up to 3 feet of snow in parts of the northern plains made river level forecasting even more difficult, as the water content and rate of melting of this new snow added another variable to the equation. Several records set by the Red River included:

Wahpeton--19.2 feet
 Fargo--39.6 feet
 Grand Forks--54.0 feet
 Pembina--54.9 feet

The Red River broke a 100 year flood crest record of 39.1 feet at Fargo, ND on Thursday, April 17th, 1997, when the river crested at 39.6 feet (22.6 feet above flood stage). Federal disaster aid was made available for people and communities in the Dakotas and portions of Minnesota. The declaration covered damage resulting from flooding, severe winter storms, high winds, heavy spring rain, rapid snow melt, and ice jams.

North Dakota reported seven deaths, while Minnesota reported four deaths due to the flooding. Approximately 90 percent of Grand Forks was under water at one point as the Red River crested at 26 feet above flood stage and remained near that level for several days. Approximately 60,000 residents were forced to evacuate Grand Forks and East Grand Forks. In the Grand Forks area alone, overall damages and cleanup costs were estimated in the \$1-2 billion range.

The Minnesota River also caused a great deal of damage, although less extensive than the Red River. Finally, North Dakota's Devils Lake expanded to more than twice its normal size, which caused local flooding in the area.

This was the third major flood event of the past five months in the U.S. The first two were the California and northwest flooding of late December - early January, followed by the Ohio Valley flooding in early March. Damages for these events (combined) probably exceeded \$4 billion.

Description of Figure (times are UTC, subtract 5 hours for Eastern Standard Time, 6 hours for Central Standard Time):

Figure 9: POES AVHRR visible image at 1947 UTC on April 12, 1997, showing the extensive snow cover and swollen rivers in the area.

TEXAS TORNADOES

On May 27, 1997, unstable conditions developed aloft as an upper level system moved over Texas from the west. At the surface, a cool front moving south was intersected by an outflow boundary from a thunderstorm moving southwest in central Texas. Conditions in this part of Texas were warm and humid with a southerly flow and dew points in the mid to upper 70's. Violent thunderstorms then erupted over central and south central Texas during the afternoon, producing at least six tornadoes which decimated parts of four counties from Waco to Austin.

One tornado destroyed an entire subdivision in Jarrell, Texas, in Williamson County where at least 27 people died and dozens more were hurt.

Also, two people were killed in Austin (one by flash flooding), bringing the overall death toll to 29. A tornado warning for Williamson County was issued by the National Weather Service 35 minutes before the tornado struck Jarrell. Damages were estimated to be in the \$50-\$100 million range. Other locations that received very high thunderstorm-produced winds included Austin with a 71 mph gust and Kelly AFB with a 122 mph gust.

The Jarrell tornado was probably a Fujita scale F5 tornado according to National Weather Service officials who surveyed the area. Less than one percent of all tornadoes are rated that severe. Last year's only F5 hit Oakfield, WI on July 18. As of May 28, 1997, 67 tornado-related deaths had been reported nationwide versus 24 for all of 1996. All 67 of these deaths have occurred in tornado watch areas (i.e., watch active at the time).

Historical tornadoes in Texas that were even more deadly include:

Saragosa - May 1987 - 30 killed.

Wichita Falls - April 1979 - 42 killed.

Waco - May 1953 - 114 killed.

Description of Figures (times are UTC, subtract 5 hours for Eastern Standard Time, 6 hours for Central Standard Time):

Figure 10: GOES colorized infrared image at 2045 UTC on May 27, 1997, showing explosive thunderstorm development over parts of Texas. The coldest (strongest) thunderstorm tops appear dark red.

Figure 11: GOES visible image at 2045 UTC on May 27, 1997, showing close-up of thunderstorm development over Texas.

Figure 12: GOES colorized infrared image at 2345 UTC on May 27, 1997, showing continued expansion of thunderstorms over Texas.

Figure 13: NEXRAD base reflectivity image of the Jarrell, TX tornado event taken from level II data from the Austin, TX WSR-88D radar site.

Figure 14: NEXRAD base velocity image at 2043Z on May 28, 1997. The color green has been assigned to the winds moving toward the radar site and red for winds moving away from the radar site. The more intense the colors, the greater the wind velocity. Cyclonic rotation occurs when the maximum inbound wind is to the left (as seen from the radar) and the maximum outbound wind is to the right. Note the intense gate-to-gate (side-by-side) azimuthal shear indicated by the arrow. These images were obtained using NEXRAD level II data from the Austin, TX WSR-88D radar site.

ADDITIONAL INFORMATION

Additional satellite images, movie loops, and NEXRAD images are available on NCDC's WWW pages for these events--accessible at <http://www.ncdc.noaa.gov/rcsg/weather-events.html>. Additional data (surface observations, precipitation amounts, upper air data, satellite images, and NEXRAD data) are available from NCDC as follows:

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Fax: 704-271-4876
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ACKNOWLEDGMENTS

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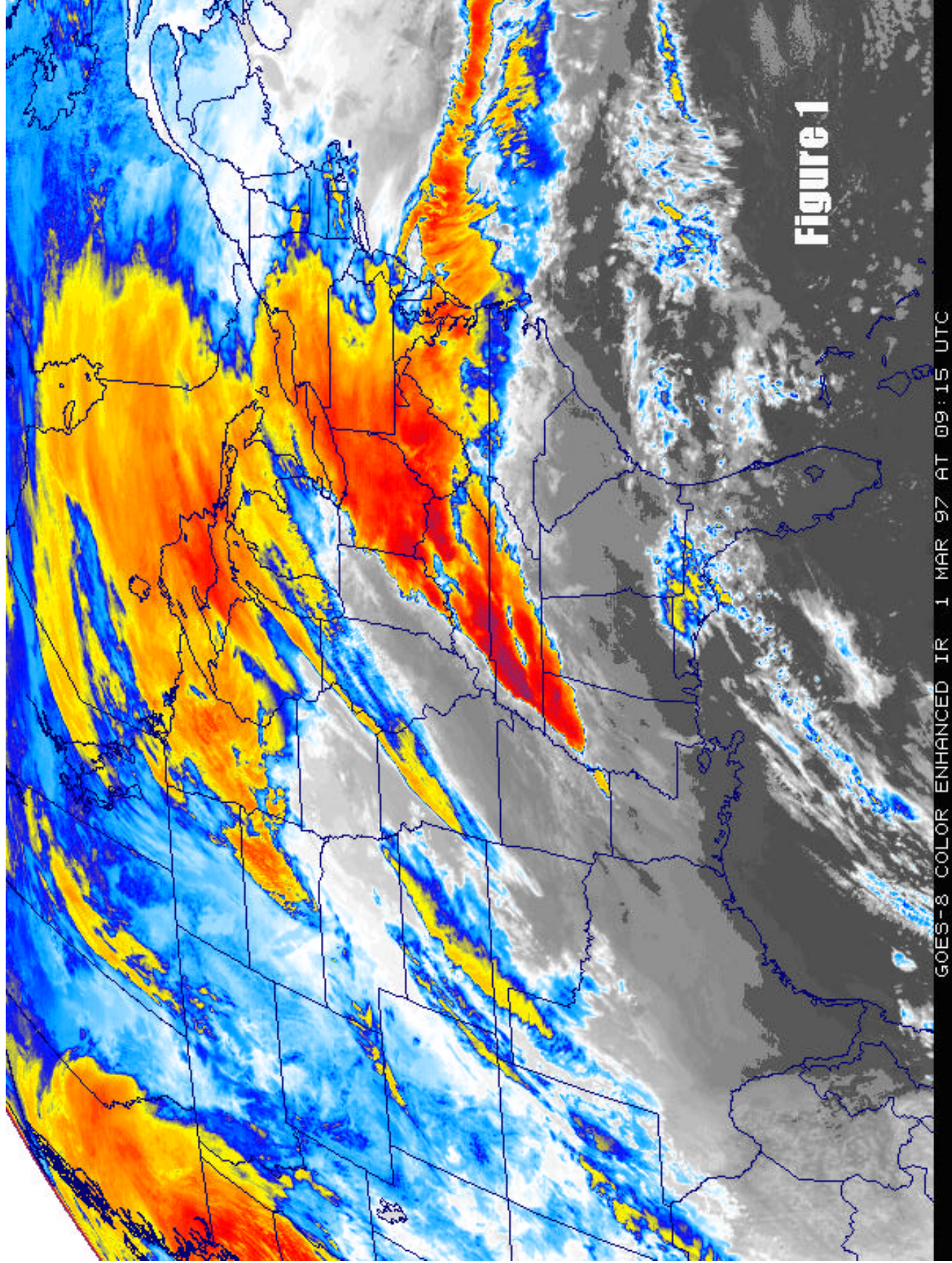


Figure 1

GOES-8 COLOR ENHANCED IR 1 MAR 97 AT 09:15 UTC

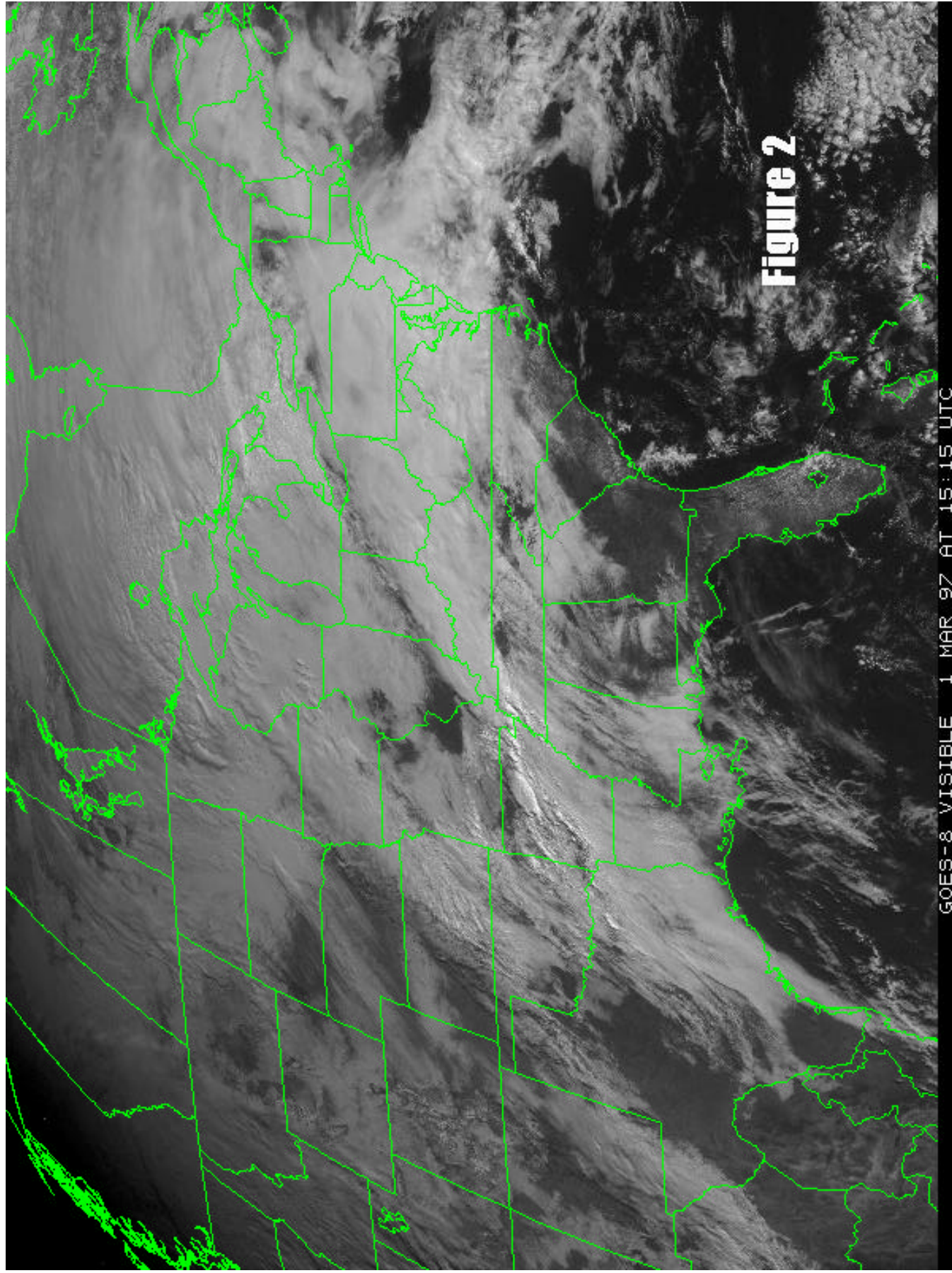


Figure 2

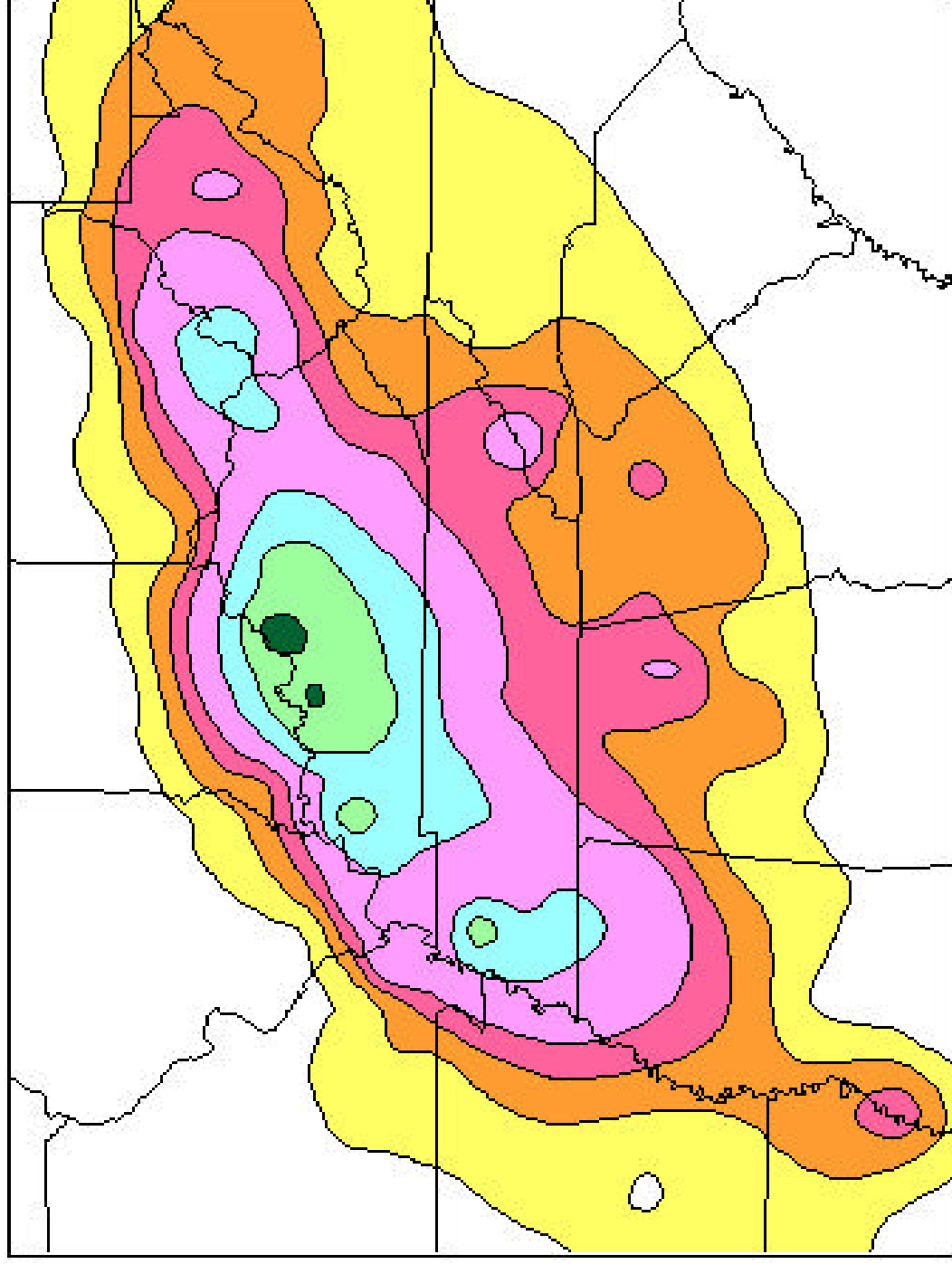
GOES-8 VISIBLE 1 MAR 97 AT 15:15 UTC



Figure 3

GOES-8 VISIBLE 1KM RESOLUTION 1 MAR 97 AT 20:45 UTC

Total Precipitation (inches), February 28-March 3, 1997



Precipitation (inches)

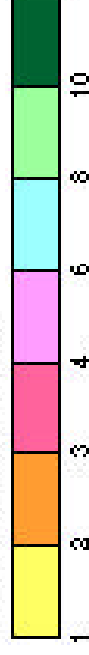
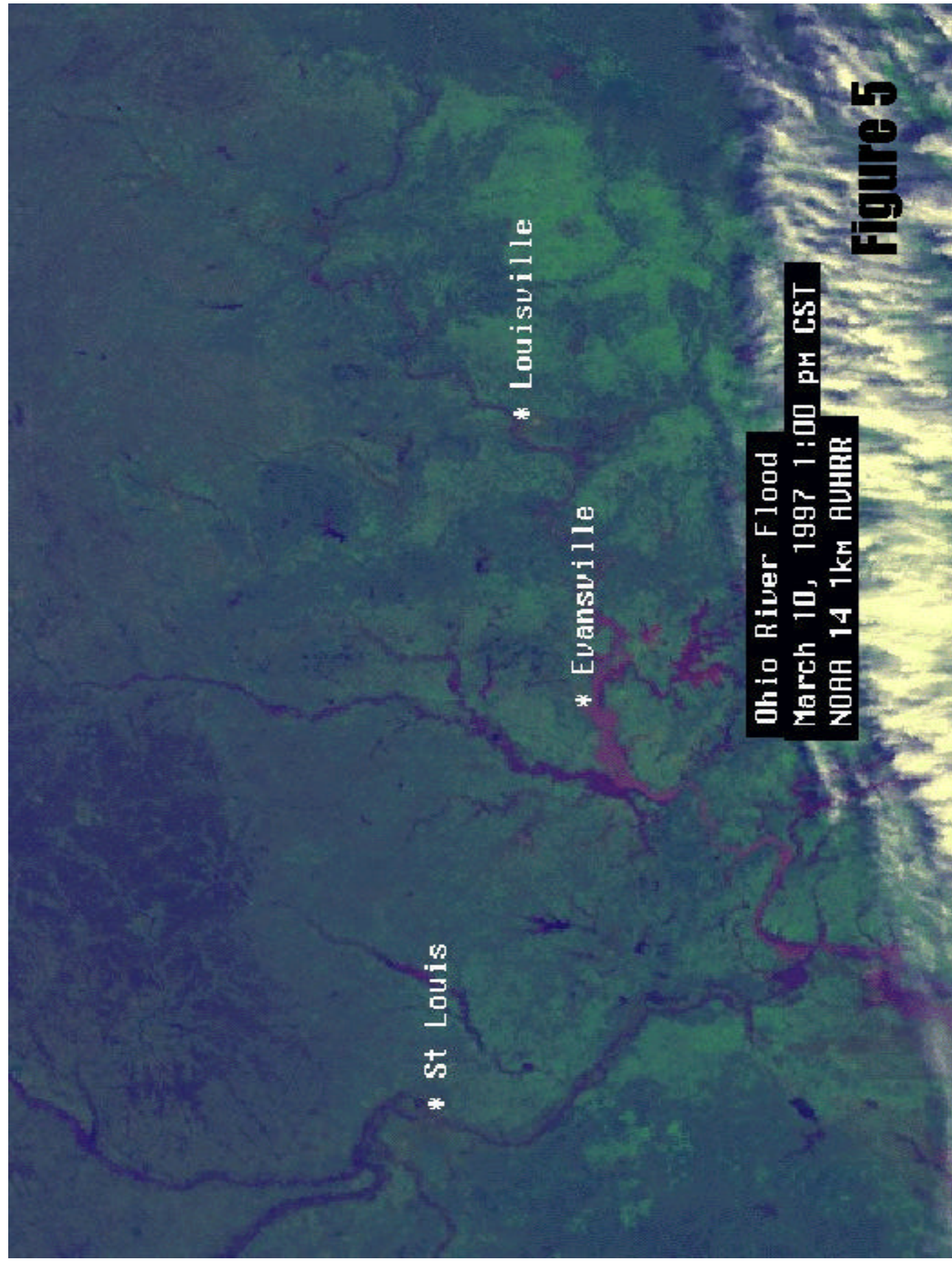


Figure 4



* St Louis

* Evansville

* Louisville

Ohio River Flood

March 10, 1997 1:00 pm CST

NOAA 14 1km AVHRR

Figure 5

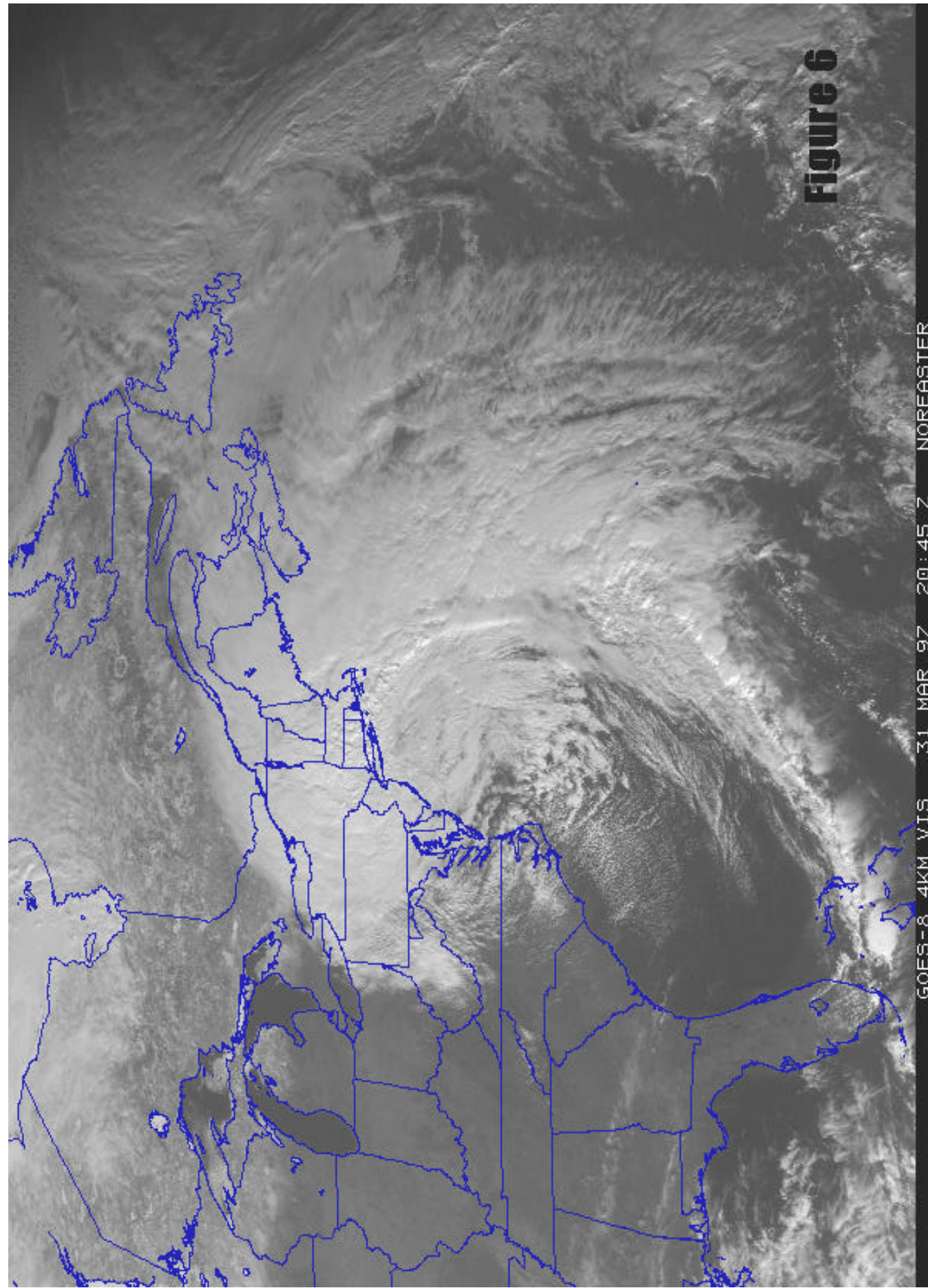


Figure 6

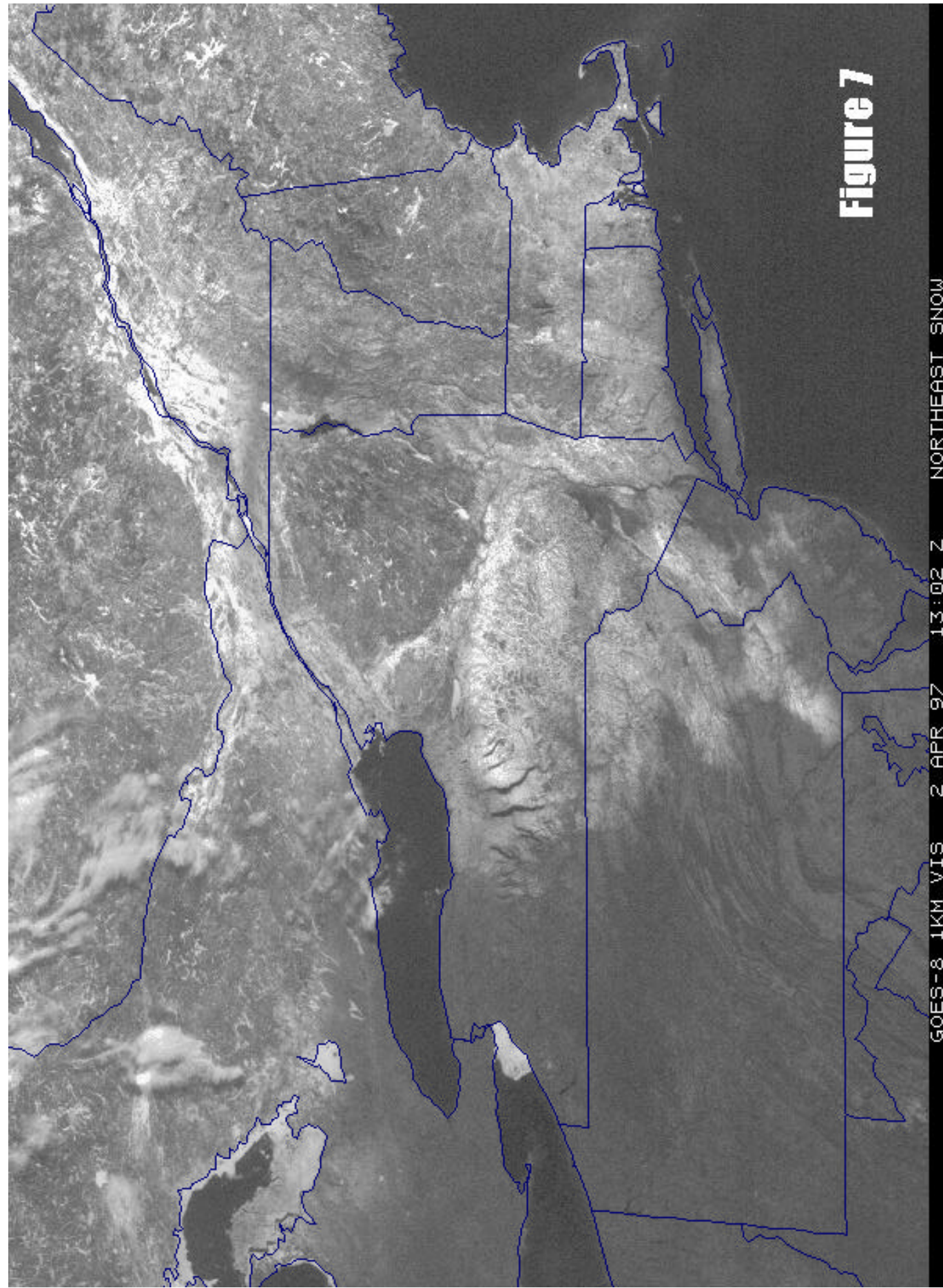


Figure 7

Total Snowfall (inches),
March 30-April 1, 1997

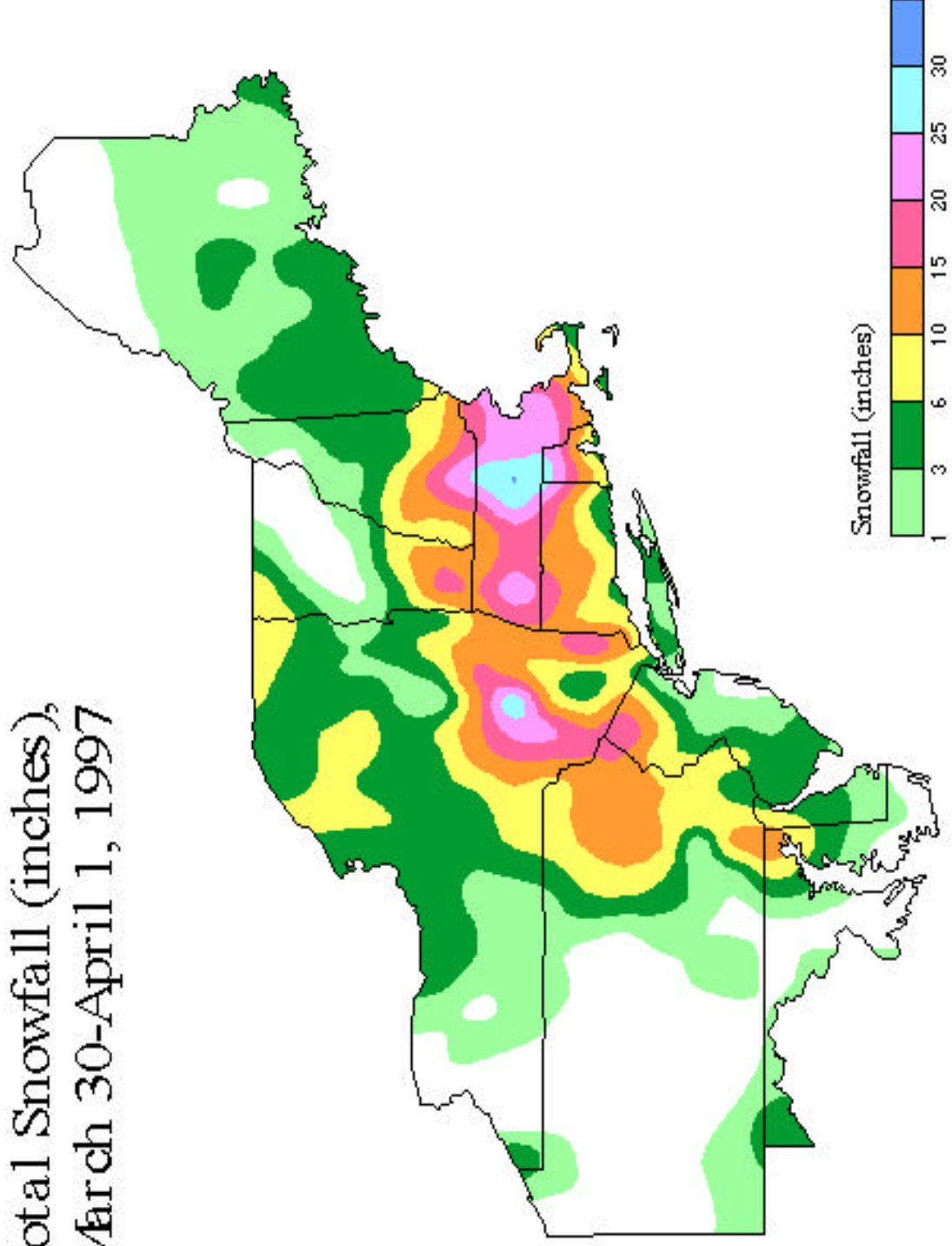
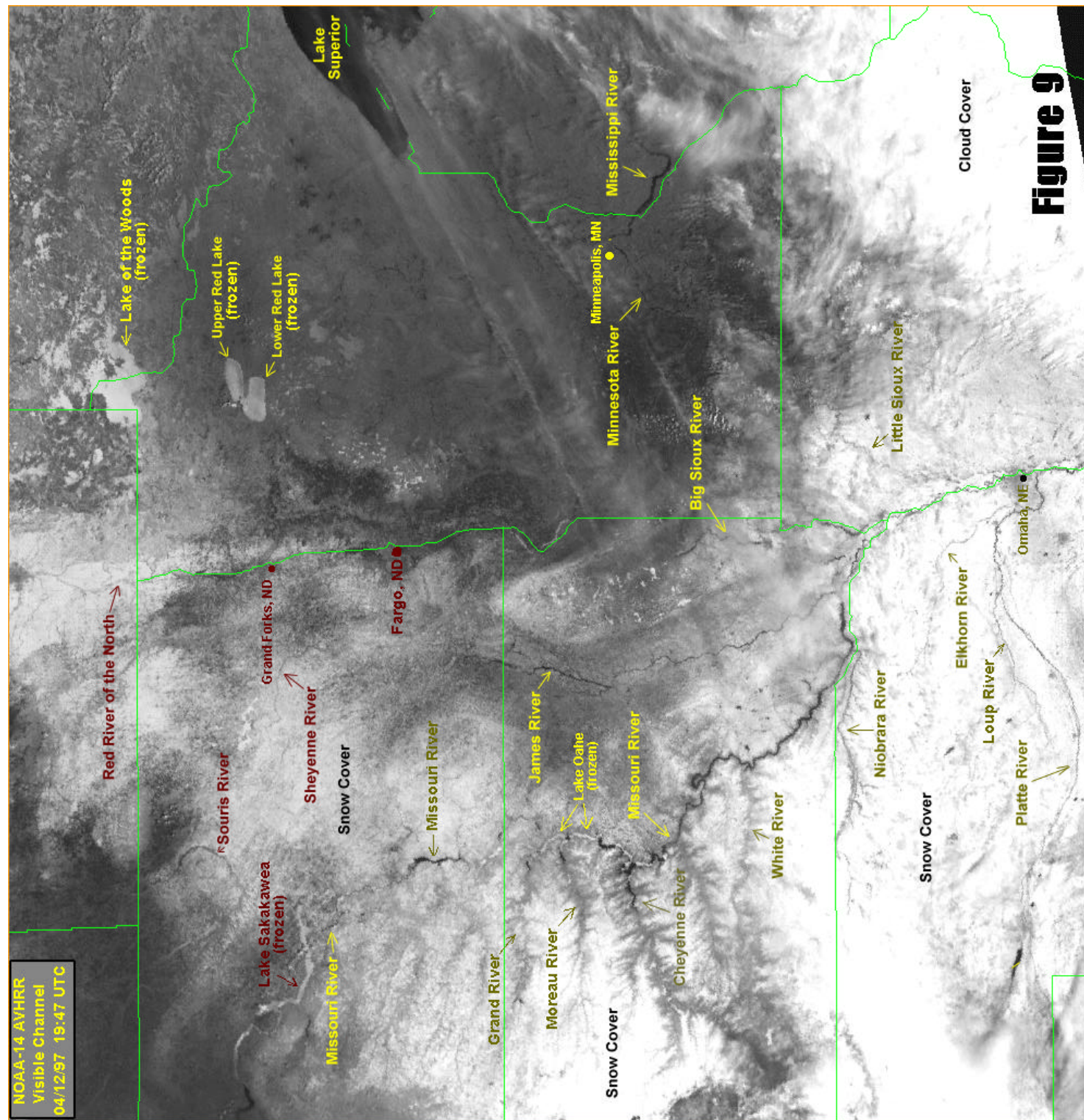
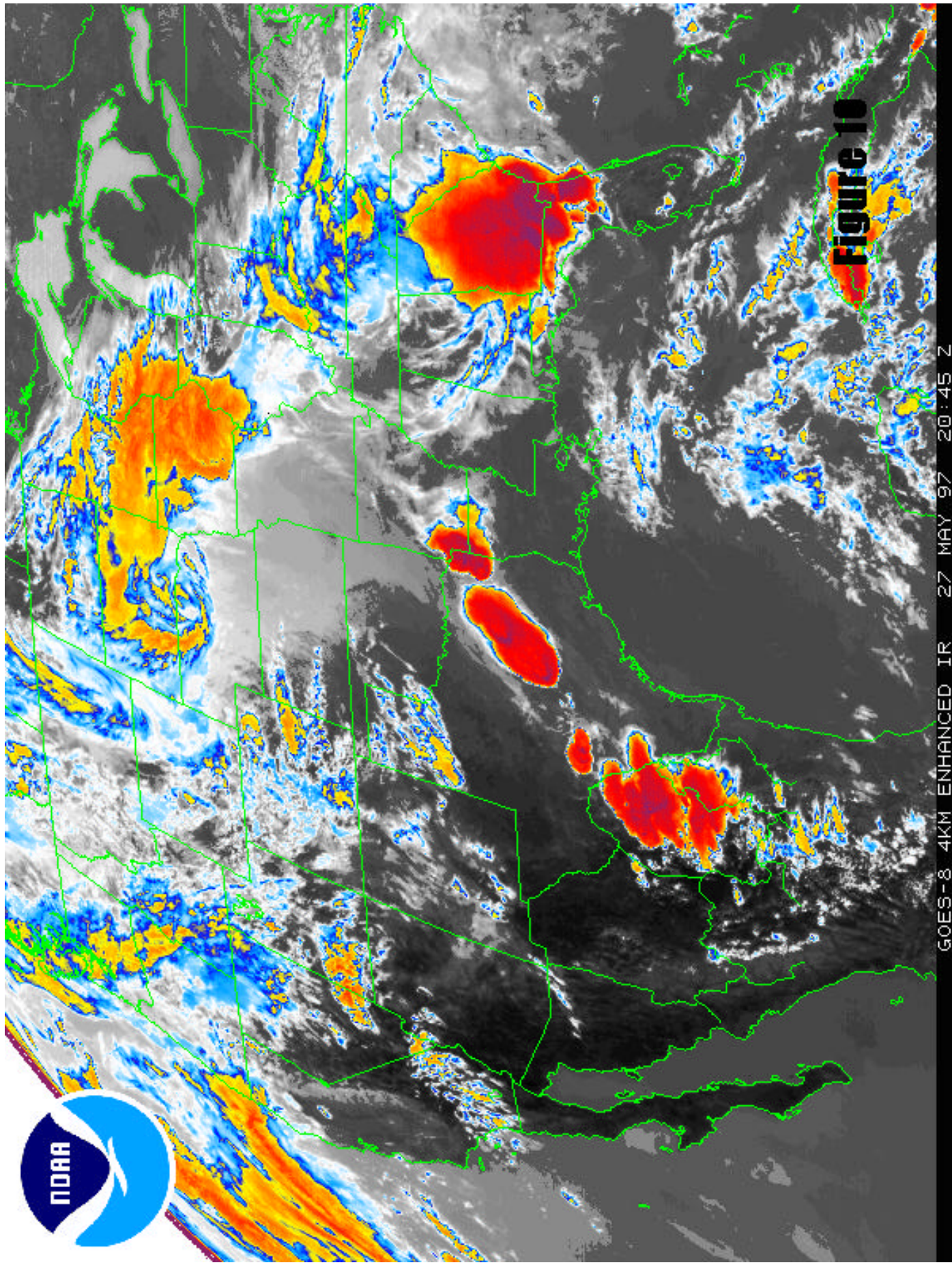


Figure 8





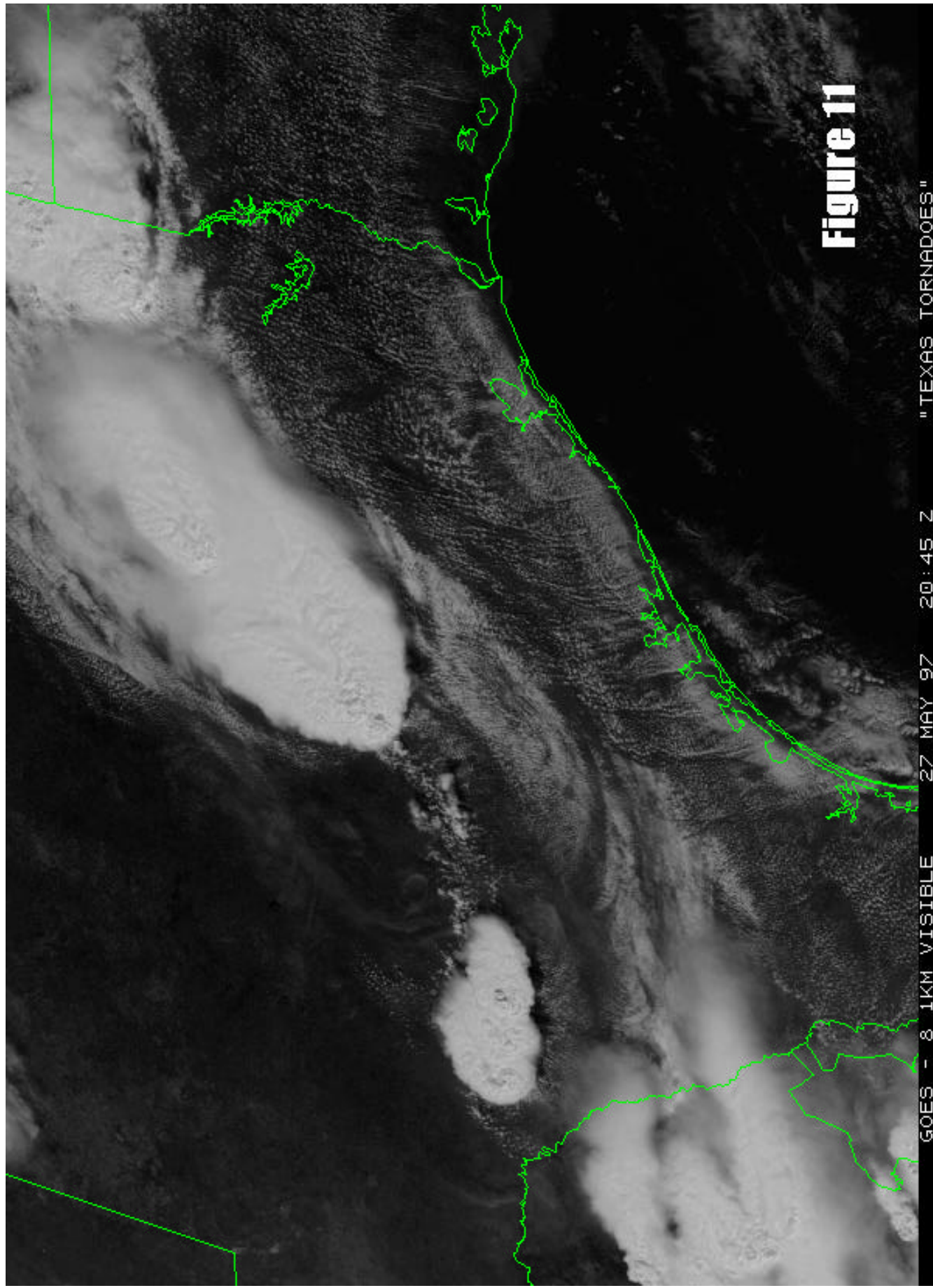


Figure 11

GOES - 8 1KM VISIBLE 27 MAY 97 20:45 Z "TEXAS TORNADOES"

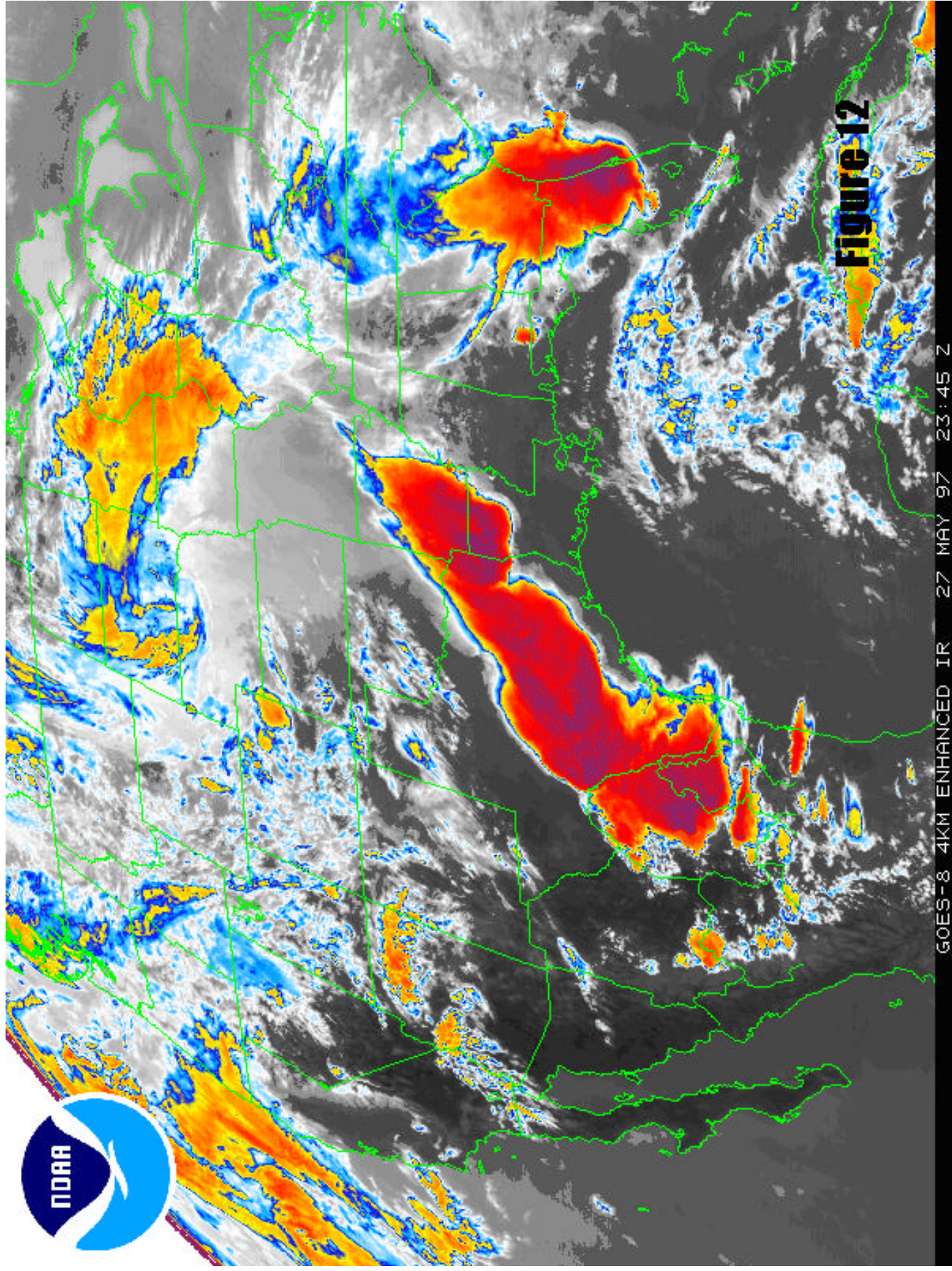


Figure 12

